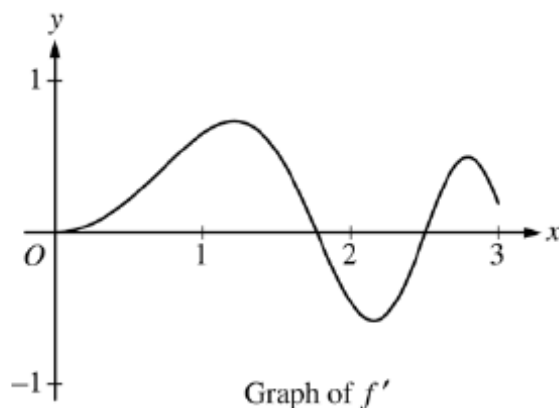


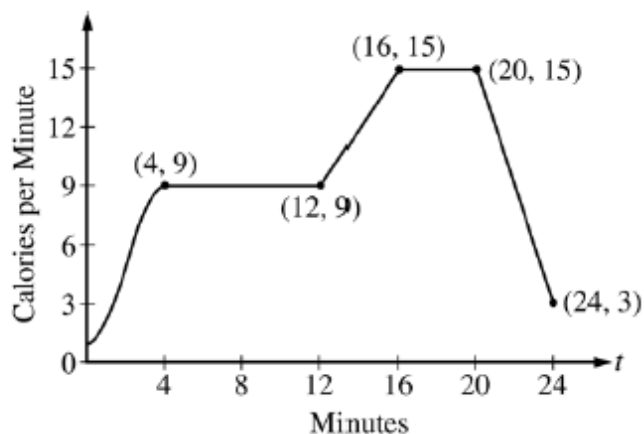
1.



Let  $f$  be the function defined for  $x \geq 0$  with  $f(0) = 5$  and  $f'$ , the first derivative of  $f$ , given by  $f'(x) = e^{(-x/4)} \sin(x^2)$ . The graph of  $y = f'(x)$  is shown above.

- Use the graph of  $f'$  to determine whether the graph of  $f$  is concave up, concave down, or neither on the interval  $1.7 < x < 1.9$ . Explain your reasoning.
- On the interval  $0 \leq x \leq 3$ , find the value of  $x$  at which  $f$  has an absolute maximum. Justify your answer.

2.



The rate, in calories per minute, at which a person using an exercise machine burns calories is modeled by the function  $f$ . In the figure above,  $f(t) = -\frac{1}{4}t^3 + \frac{3}{2}t^2 + 1$  for  $0 \leq t \leq 4$  and  $f$  is piecewise linear for  $4 \leq t \leq 24$ .

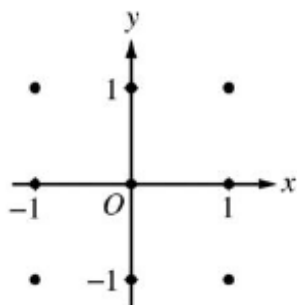
- Find  $f'(22)$ . Indicate units of measure.
- For the time interval  $0 \leq t \leq 24$ , at what time  $t$  is  $f$  increasing at its greatest rate? Show the reasoning that supports your answer.

3.

Consider the differential equation  $\frac{dy}{dx} = (y - 1)^2 \cos(\pi x)$ .

(a) On the axes provided, sketch a slope field for the given differential equation at the nine points indicated.

(Note: Use the axes provided in the exam booklet.)



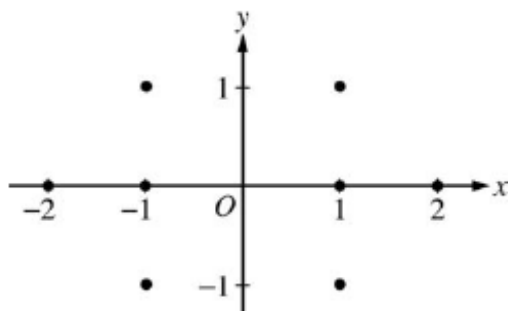
(b) There is a horizontal line with equation  $y = c$  that satisfies this differential equation. Find the value of  $c$ .

4.

Consider the differential equation  $\frac{dy}{dx} = \frac{1+y}{x}$ , where  $x \neq 0$ .

(a) On the axes provided, sketch a slope field for the given differential equation at the eight points indicated.

(Note: Use the axes provided in the pink exam booklet.)



5.

The twice-differentiable function  $f$  is defined for all real numbers and satisfies the following conditions:

$$f(0) = 2, \quad f'(0) = -4, \quad \text{and} \quad f''(0) = 3.$$

(a) The function  $g$  is given by  $g(x) = e^{ax} + f(x)$  for all real numbers, where  $a$  is a constant. Find  $g'(0)$  and  $g''(0)$  in terms of  $a$ . Show the work that leads to your answers.

(b) The function  $h$  is given by  $h(x) = \cos(kx)f(x)$  for all real numbers, where  $k$  is a constant. Find  $h'(x)$  and write an equation for the line tangent to the graph of  $h$  at  $x = 0$ .